EXHIBIT A

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---------- **Patent Application JP60-154470(A)** ----------

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SPECIFICATIONS

1. Title of the Invention

Fuel Cell

2. Claims

A fuel cell consisting of single cells that consist of fuel poles and air poles that include electrolyte matrices and in which gas passage grooves are formed, a plurality of the single cells being layered and separated by separators, such fuel cell characterized by employing separators that are coated by the chemical gas phase sputtering method with titanium carbide on steel sheet, stainless steel sheet or aluminium sheet

3. Detailed Description of the Invention

Relevant field of industry

This invention relates to fuel cells, and more particularly to separators that prevent the mixing of the fuel and oxidizing gases.

Prior art and problems thereof

Fuel cells are normally electricity generation devices in which the electrolyte is gripped between a pair of porous electrodes and the reverse surface of one electrode is in contact with hydrogen and so forth and the reverse surface of the other electrode is in contact with an oxidizing agent such as oxygen and so forth, and the electrochemical reactions that then arise are employed to collect electrical energy from between the electrodes.

The constitution of individual fuel cells based on this principle and which in particular employ phosphoric acid as the electrolyte and in which gas grooves for the passage of gas are formed in the porous electrodes is shown in Figure 1.

In Figure 1, 1 is the fuel pole, 2 is the air electrode, 3 is the electrolyte layer and 4 is a separator that separates the individual fuel cell. 1a and 2a are catalyst layers that are disposed in the respective poles.

Hitherto, sheets of mixed and integrated graphite and thermosetting resin and/or thin sheets of sintered carbon have been employed as the separators employed in such sandwich formations, but there have been problems with the technology for the manufacture of such sheets. Thus it is difficult to mould and work sheets of 500 mm x 500 mm and of 0.5 mm to 1 mm in thickness without warping or surface irregularities and while preventing the development of cracking, and the yield of finished product has been low. For these reasons, it has been difficult to provide fuel cells exhibiting good electrical properties and that possess long service lives.

Objective of the invention

The present invention takes account of these problems and it is an objective of the invention to provide a fuel cell that possesses a simple constitution, that permits the manufacture of large thin sheets of not more than 1 mm in thickness and of at least 700 mm x 700 mm in shape, and that employs separators that possess relatively good electrical conductivity and long service lives.

Description of the invention

The particular feature of the present invention is the use of separators that are coated with titanium carbide by means of the chemical gas phase sputtering

method onto the surfaces of sheets of steel or stainless steel or of aluminium strip.

Such sheet and strip can be manufactured by the rolling and so forth of metal sheet to relatively thinness by known art and is readily procurable in the market. However, when such sheet and strip is employed directly as separators, the separators are invaded by the electrolyte with the result that in the individual cells local corrosion develops and an oxide film is formed on the metal surface of the air pole with the result that the separator is unable to sustain its function over a long period of time. It was apparent that such corrosion and formation of oxide films could be prevented by means of the coating of the surfaces with substances that were electrically conductive and that were resistant to corrosion and oxidation, and hence the present invention was perfected. Titanium carbide can be employed as such a material. Moreover, it is possible to form titanium carbide uniformly onto a metal surface from the chemical gas phase and hence it is possible to prevent spot corrosion through pinholes and the like, therefore making it possible to extend the service lives of the separators.

Effects of the invention

The present invention permits large separators with few defects and hence with good conductivity and long service lives, and greatly improves the properties and service lives of fuel cells.

Practical embodiment

A practical embodiment of the fuel cell envisaged by the present invention is described.

Figure 2 is a drawing intended to explain the method of formation of the separators that are the essential feature of the present invention; a gas supply route 11 to which a gas supply source 12 was connected was provided at one end of the reaction vessel 10 and a gas exhaust route was provided at the other end of the reaction vessel. The gas supply source 12 was formed by heating 1 *l* per minute of propane (C_3H_8) as a carbon source in the heater 14 and maintaining the propane at 70°C and passing it through titanium tetrachloride and adding from 50 cc to 100 cc of hydrogen. The reaction vessel 10 consisted of an electric oven which was maintained at 800°C. A sample consisting of aluminium sheet 700 mm x 700 mm x 0.5 mm thick was held in the reaction vessel 10 of this reactor, and a uniform coating of TiC was obtained on the surface of the aluminium sheet in 3 to 4 hours through the reaction $TiCl_4 + C_3H_8 + H_2 \rightarrow TiC$. In this case, propane was used as the carbon source, but ethane,

methane and propylene and so forth may also be employed, and the sample may also be SUS 304 stainless steel sheet or other ordinary steel sheet.

When compared with the resin-bonded graphite separators and sintered carbon of the prior art, such separators can be manufactured inexpensively with a good yield (80%) (not more than 40% for products of the prior art) and the metal sheet is manufactured and is available in large quantities on the commercial market. The actual fuel cell was constituted of the separators manufactured in this manner by combining the separators in a sandwich formation with individual fuel cells as illustrated in Figure 1. The fuel cell was run for 10,000 hours and was then disassembled and inspected, and when the individual separators were examined for damage, no separator was found to exhibit spot corrosion or alteration.

In the fuel cell envisaged by the present invention as described in the foregoing, the separators that are the essential element are simple to manufacture and moreover are manufactured inexpensively, rendering the technique of industrial value.

4. Simplified description of the drawings

Figure 1 is an inclined view of portion of a disassembled fuel cell and Figure 2 is a schematic drawing showing portion of the apparatus for the manufacture of the separators that are an essential element of the fuel cell envisaged by the present invention.

1 ... Fuel pole, **2** ... Air pole, **3** ... Electrolyte layer, **4** ... Separator

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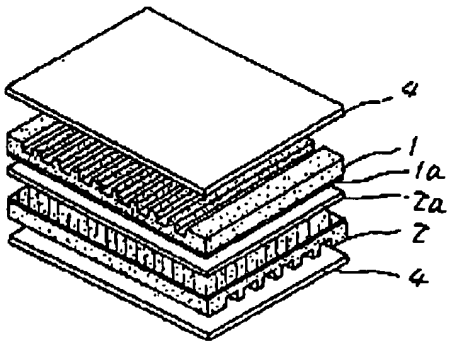

Figure 1

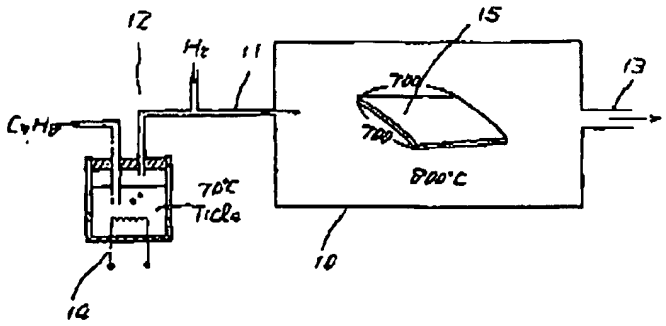

Figure 2